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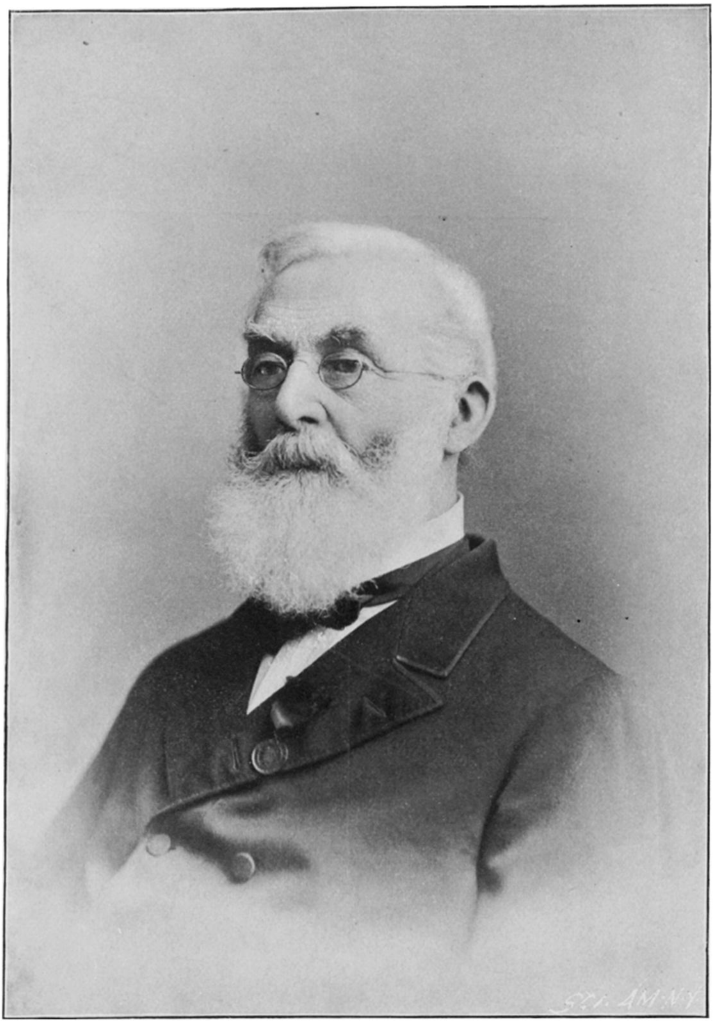

JAMES HALL.

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RELATION OF JAMES HALL TO AMERICAN GEOLOGY.

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PROFESSOR JAMES HALL may not be so good a geological delineator as W. W. Mather, nor so keen or so original a thinker in dynamical geology as E. Emmons, a less learned man than Lardner Vanuxem, and in no respect so accomplished a zoologist as T. A. Conrad ; yet the fame of James Hall will, meritoriously, far outrank the collective reputation of his four collaborators.

Hall was gifted with the power of generalization, a distinct talent to give territorial expansion to groups of separated observations, and to step outside of the limits of a conventional geological creed. And he possessed the faculty of assimilation. He derived important suggestions from previous research, listened attentively to verbally conveyed views, and could appropriate skillfully the results of labors not his own, when they fitted into the scheme of his laborious research. As a purely mechanical advantage, Hall evinced a literary superiority. His style is flowing and expressive, of much lucidity in language, and — simply because he was not an erudite or exhaustive thinker — attractively clear and intelligible in composition.

In Hall there was a distinct philosophical aptitude, sometimes evinced in remarks outside of the range of strictly scientific study, and this philosophical instinct led him into paths of induction which freed him from the bonds of stereotyped views in science itself. This *disquisitional* quality, as I venture to call it, is not inconsiderably shown in the opening pages of his "Preliminary Considerations" to the *Report on the Geology of the Fourth District*, in the same way that the pedagogical strain of his mind appears in the two or three succeeding chapters of the same work.

As illustrating both of these traits, under a somewhat oracular disguise, the following paragraph is of interest. It closes some remarks made upon the absence of the coal formations in New York State, for whose fancied presence money and labor had been unavailingly expended in exploration :

"It is thus negatively, as well as by direct and positive discoveries, that science ameliorates the condition of mankind; turning attention from useless and visionary pursuits, and directing it to that which yields a ready and satisfactory result for the expenditure of labor and time. And although the promulgation of scientific truths may restrain the vagaries of minds which delight to build the splendid air castles of suddenly acquired wealth, it will, nevertheless, direct man's energies to sources where perseverance is sure to be crowned with rewards which a morbid fancy would crave at the commencement of the enterprise. From science alone will man learn his true interests as regards his well-being in the world."

It was the philosopher in Hall which led him along the lines of wide conclusions so favorably and notably shown in the introduction of vol. iii of the *Paleontology of New York*. Here, as Walcott once remarked to the writer, "the substantial worth of Hall as a geological writer is fully illustrated," for in these ninety-six pages he sketches with considerable mastery at least, the relations of the palæozoics in the east, points out the misleading assumption of a Taconic system, and projects the theory of troughs of sedimentation as essential causes of mountain-making, a theory he had before laid before the scientific world in the *Proceedings of the American*

Association for the Advancement of Science. It was the philosopher in Hall which as early as 1839 or 1840 led him to instinctively enlarge and multiply the observations of Vanuxem, published in 1829, upon the identity of western formations with those of New York. It was the philosopher in Hall which saved him from Eaton's mistake in applying Wernerian categories to the New York rocks, and caused him to sweep the cobwebs of imitation and preconception from his eyes as he read the story of geological succession in their strata. He corrected the "distortion" (as he expressively termed it) which had made the even bedded layers of western New York equivalents of the so-called "secondary" rocks abroad, and discarded the illusion of an exact resemblance in the geology of Europe and America.

But this philosophic endowment did not endanger his physical activity. Less poetic and distinguished in mind or temperament than the Professors Rogers, his tireless curiosity and enthusiasm brought him in contact with a wider range of geographical and geological facts. He traveled extensively and made the results of his experience and his collections bear upon the elucidation of the geology of New York State.

It was fortunate that a philosophical mind, one addicted to comparison and induction, and not gifted either with marked scholarship or originality, should have been committed to the task of studying a section (the Fourth District) of the state where the succession was almost undisturbed, where leaf upon leaf, with contents unobliterated, the geological record, waited for its reader. Hall read the record and established the *pagination* of the opening sections of the Book of Geology for America. Imbued with lasting impressions of a quiet and continuous progress of deposition, marked by no more extreme perturbations than the secular rising and falling of the earth's crust, he became a strict Uniformitarian, and the problems of volcanic geology, which lay far outside of his path, seldom or never enlisted his attention. He writes in the *Geology of the Fourth District* (p. 10) : "The doctrine of violent catastrophes, and of sudden changes in the inhabitants of the ocean, was based upon the examination of limited districts, where the entire series of deposits had never existed, or had been subsequently obliterated. And gradual and tranquil as the changes now seem to us, they may appear infinitely more so when a perfect sequence among the strata of the whole globe shall become known — when a *complete* succession shall be established from the oldest to the newest rock. From what we now know, compared with the knowledge existing a few years since, we can readily infer that some distant places, or even nearer localities, may furnish links now wanting in the chain." Hall's phenomenal vitality carried him through a period of geological research in which some of his expectations were verified.

The Fourth District, extending from Chautauqua and Niagara on the west to Wayne and Chemung on the east, was practically fully deciphered by Hall in its intrinsic stratigraphy, though the exact and complete outline of its formations has only recently been mapped. This region, so uniformly constructed, and referring so perspicuously to its origin in just such conditions as prevail along the margins of existing continents, appealed strongly to Hall's logical temperament. He writes of it :

"The analogy to recent formations is thus more fully seen; for we have precisely the same materials, differing only in degree of induration. We have the unaltered monuments of a widespread ocean teeming with life, and we find recorded its changes through vast periods of time. We now learn what were the conditions of its bed at these successive periods, and also what different characters it presented at distant points. The varying forms of its inhabitants are as well marked and as perfectly preserved as the recent species amid the mud and sand and pebbly bottoms of our present seas. The geographical limits of certain genera and species are as well defined in that primeval ocean as in the present; and, as now, upon the same bottom, we find in some places great accumulations of organic forms, while in others they are rare or wanting. Like our present ocean also, we know that this ancient one was agitated by winds and moved by tides; the drifted shells and comminuted corals tell us plainly of waves and currents, while in other places the fine sediment and equally distributed organic remains speak either of a quiet sea or deep water, where they were placed beyond the tumult that might have raged nearer the surface."

Hall's study of this succession, and the generally increasing thickness of deposits to the east along the Appalachian uplift, his generalizations upon the continuity of these beds westward, and his growing realization of successions of fauna, with more or less clear appreciation of local variations in fauna, were resumed in the interesting and able introduction to vol. iii of the *New York Paleontology* (1859). The fact of the preponderant accumulations of sediment along the Appalachians had been reviewed and studied by him with an increasing certainty of divination that the association of these heavy deposits with the mountain chain itself was in the nature of a causal connection.

Hall had apprehended with his usual power of appreciative insight the dissertation of Herschel on the mobility of the earth's crust, and it was an exhibition of hermeneutics in geological science which read into the facts of the Appalachian tumulus the specific applicability of the suggestion. Here he saw a continental ridge made up of sedimentary rocks, twisted and folded, to be sure, and showing the results of powerful compression. But the mass, the vast aggregate of its limestones, slates, and sandstones, was sedimentary, and these deposits were evidently concentrated along a meridional crease, a trough or depression secularly raised and lowered. This path of sedimentation against and over an oscillating shore line provided the material, when raised, for a mountain chain. The trough was itself an inverted mountain ridge, and nowhere else was there such an adequate supply of *mass* to create an imposing elevation when lifted. As Hall succinctly said: "At no point, nor along any line between the Appalachian and Rocky mountains, could the same forces have produced a mountain chain, because the materials of accumulation were insufficient; and though we may trace what appears to be the gradually subsiding influence of these forces, it is simply in these instances due to the paucity of the material upon which to exhibit its effects. The parallel lines of elevation, on the west of the

Appalachians, are evidenced in gentle undulations, with the exception of the Cincinnati axis, which is more important, extending from Lake Ontario to Alabama, and is the last or most western of those parallel to the Appalachian chain."

It does not appear clearly that the physical consequences of his views were ever elaborated in his own mind, or that the thermal features of the problem, as somewhat narrowly presented by T. Mellard Reade, were studied. Indeed, there is discernible in Hall's writing a shrinking from the reference of mountain topography to dynamical agencies, but a quick response of interest to their indications of sculpture by erosion. If we might venture a pleasantry, we should say that if Professor Hall, as *deus ex machina*, had been permitted to have his own way, the Catskill rather than the Appalachian type of mountains would have been most widely distributed over the earth's surface.

Certain metamorphism and folding were recorded, and the contrasted phases of mountain-making exhibited in the Catskills and the Appalachians pointed out, but the metamorphism and folding were referred to the consequences of *weight* and not to crustal shortening. Here again Hall was quick to respond to contemporaneous investigation. He recognized that the facts of metamorphism did not require an enormous heat, and hinted at those hydrothermal processes which lithologists now find so active and efficient in producing mineral alteration. He says: "We must therefore look to some other agency than heat for the production of the phenomena witnessed; and it seems that the prime cause must have existed within the material itself, and that the entire change is due to motion, or fermentation and pressure, aided by a moderate increase of temperature, producing chemical change."

The view of mountain-making propounded by Hall was an illustration of common sense illumined by thought and observation. Yet it was in the nature of a revelation. Le Conte has told us "the idea was so entirely new, so utterly opposed to prevailing views, that it was wholly incomprehensible even to the foremost geologists. There was no place in the geological mind where it could find lodgment. It was curious to observe the look of perplexity and bewilderment on the faces of the audience. Guyot was sitting immediately behind me. He leaned forward and whispered in my ear, 'Do you understand anything he is saying?' I whispered back, 'Not a word.'" This was scarcely a reflection on the intonation of the reader, but a truthful picture of mental consternation. Yet physico-chemical and mathematical obscurities could hardly be expected from Hall. The promulgation of his theory of mountain-making evinced and was the result of the instinct and experience of a stratigrapher.

It is impossible to read the dignified reports of the first, second, third, and fourth districts, strong and copious contributions to geology at a period in our scientific life when, except for differential or sporadic work at the hands of Eaton, McClure, and Featherstonhaugh, and more consecutive efforts from Jackson, Hitchcock, Troost, Percival, and Owen, nothing had been done in geology of commanding excellence — except the great work of the Professors Rogers — it is impossible to read these productions without being struck with the literary smoothness and the mental solidity of the *Report on the Fourth District.*

Here the pervading skill of presentation admirably expresses the geological simplicity of the facts. But the care and beauty of demonstration are happily united with suggestion. At one point we are invited to consider the varying rates of deposition for fine or heavy sediments, at another the character of shore and off-shore deposits, here the mechanics of river erosion are discussed, and there the alternating velocity and slowness of tides. We ponder on the changing colors of strata and what they mean, or are made to feel by some analogy how real those ancient beaches and ocean beds were. We are carried across Lake Ontario, and shown the Laurentian base of our system upon which in shelving order the later formations lie, appearing on the southern borders of the lake as the Upper Silurian; and the realization of this is made distinct and memorable.

Hall's relation to American geology is that of the *illuminator.* He presented a broad, intelligible proposition, and on its basis a mass of evidence fell into discrete symmetry. Such was the succession of overlapping strata, their encircling lines of deposition around an interior basin, the Taconic system as a changed Silurian system, mountains as rock heaps, faunal categories, and cycles.

This illuminating power was indeed due to a certain plainness in Hall's mind that led him to reject arduous and difficult theories. And it led him on the straight sunlit path when a more abstruse mind would have been, with great effort, working away from the truth underneath the ground. The work of correlation of the fossil horizons of the United States, done by Hall, was largely based upon fossil evidence as well as topographic continuity, and this correlation personally established by himself, as it was more and more supported by fresh evidence and new workers, laid bare the simplicity of the geology of the east and middle United States.

Indomitable in desire as he was in spirit, Hall reached the Rocky Mountains and established some of the first identifications of the Cretaceous in the west, and had begun there to show its varying character.

It belongs to the sensibleness of the man, the quality that often in other walks of life is the boon and the compensation of mediocrity, that Hall exercised a conservative influence in the terminology of the New York system. The names used by the New York geologists for the palæozoic formations remain, and are now printed as indelibly in memory as they are in books. They carry with them no euphonic distinction. They are not made educationally suggestive. They are eminently commonplace, and their *raison d'être* is absolutely obvious. Potsdam, Chazy, Calciferous, Black River, Trenton, Utica, Hudson River, Clinton, Medina, Niagara, and the rest are all place names easily understood, easily remembered, and have been easily applied to beds at localities most remote from all of them. Plain men like them, and scholars, have not replaced them by anything more refined. In this respect geology has both set and followed this example.

It belonged to the logic of Hall's mind and a certain original fixity of idea in him to combat Emmons' Taconic System. He rejected the injection of a new series of horizons. It complicated matters, and Hall shrank from enigmas. He looked upon the schists, slates, and marbles of the green hills of Vermont as altered silurian sediments, and it has been the great distinction of the present Director of the United States Survey to prove this.

The same investigator has also vindicated the term "Hudson River" as embracing the section from the Trenton to the overlying Upper Silurian rocks, enclosing the Utica, a term instituted by the New York geologists, and more narrowly defined by Hall, though at first somewhat resisted by him.

Certainly to the far wider audience of scientific readers Hall stands as the embodiment of paleontological prestige. The enormous publications of the New York Survey, their later resplendent illustration, and the numerous dissertations and contributory essays on genera, families, morphology, and distribution of fossils, found in the *Reports of the New York State Cabinet*, have fixed the eye of attention upon Hall as a zoologist.

In no real sense was Hall a zoologist. His actual acquaintance with animal life was slight, and his system and habit of arrangement entirely mimetic. Certainly an enthusiastic and contemplative mind could hardly have escaped distinction in bringing to light the rising series of fossil forms which the regular succession of rocks displayed. Hall handled the retinue of forms thus presented with signal success. His work at first was tentative, but became increasingly valuable, especially as the influence of two great works educated his perception, and the influence of more acute zoologists, employed as his assistants, directed his discernment.

The formative influences of the Canadian Survey and Barrande's *Système Silurien* are plainly discernible in the progressive improvement of the *Paleontology of New York.* The Canadian Survey, with which for a short time he was connected, brought him into contact with a new field of fossil exploration, and he felt the stimulation of Sir William Logan as a helpful factor in his studies. The preparation of the decades and his close analysis of the graptolitic fauna were distinct advances over his former work in paleontology, wherein also it can hardly be denied that the extraordinary morphological instinct of Whitfield played a beneficial part. And in

Canada, besides the graptolites, the development of Crinoids and Cystids revealed a strange aspect of fossil life, repeated in the Niagara limestone of New York.

In Barrande's *Système Silurien*, a great work, exhaustively executed, Hall found strongly accentuated the fact of faunas and colonies, and the impression made by that work indorsed his own views and deepened them. Hall was not a thoroughgoing evolutionist, and Barrande's feelings about fixed types effected a permanent lodgment in Hall's zoological creed.

Hall's sanity, his reasonableness and restraint, is shown in his paleontological work, and reflects the sort of clarity of mind which distinguished his geological research. His literary instinct appears in his names also, which are pronounceable, well composed, and significant. His diagnosis of species and genera seemed remarkably correct. It was much later than his first work that he yielded to the solicitations of the hour and poured out species and genera so devotedly ; sometimes it is to be feared with a desire to obscure previous publications. Hall's diagnosis of Eurypterus, for instance, was admirable, though indisputably much of its perspicacity was injected from the careful comparative studies of Whitfield with Limulus. Agassiz, as is well known, coincided with these views.

The idiosyncrasies of Conrad, his unstudiousness, his carelessness and laconic methods, despite his genius in recognizing form, placed Hall's work at a surpassing distance beyond him. The appearance of the first two volumes of the *Paleontology of New York*, which were distinctively and, so to speak, indigenously Hall's work, marked a real epoch in scientific publication in this country. The wave of excitement spread abroad, and the keenest expectation was excited by the possibilities of a field of research, almost untouched, from which light might be expected upon the problems of life, new and brighter than that afforded in the similar areas of Europe.

When de Verneuil assured Hall of the striking specific contrasts, as well as the specific identities with those of Europe, amongst the fossils he was displaying to the scientific world, the path seemed opened for indefinite additions to the sum of knowledge in paleontology.

The consecutive arrangement of fossils from the various formations, their concentration in single volumes, the scale of illustration, all combined to give the publication a sort of encyclopedic character which, coupled with the promise of its continuous extension, made it a reference library of paleontology at that early day. It was continued, and as the finished and unexcelled drawings of Simpson and Whitfield, with the perfect lithography of Ast, gave it greater and greater luster, it grew upwards into the proudest monument perhaps ever erected to an American geologist.

It is interesting to read these early volumes, the starting points of American paleontology, and note the comparisons and observations. The author, with his characteristic love of illuminating observation, notes the varying character of the same species in successive beds or differing localities, compares and elucidates species, dwells on identity or contrast with European species, points out eccentricities of structure or ornament. These early volumes have a temporary, almost a temporizing character, are provisional in statement and necessarily imperfect in execution. The prolixity, evolution, and circumlocution of Barrande's work, published almost at the same time, contrasts almost amusingly with Hall's adequate but by comparison meager treatment, and of course Barrande's figures are incomparable, if a trifle mechanical and stiff. But Hall explains his own great difficulties — his small library, his distance from scientific friends, without authentic collections for comparison, in a new field, and with poor facilities for illustration. These impediments passed away. It is a part of that history of the development of paleontological science to note that at Albany was created a center of attraction and radiation, and two men became enlisted in this work whose special powers entered as determinative forces in its improvement — Whitfield and Meek. Later a higher stage even of erudition was reached, and Clarke and Beecher completed the assumption of the advanced biological expression.

What a development of scientific work in his own chosen field Professor James Hall has seen! State surveys and the marvelous rise of the government surveys started up around him, while the new energies of exploration and the deepened currents of study and insight ushered in our modern period with its exuberant hair-splitting and interminable terminologies.

Professor Hall is dead. Contest and contestant sleep in one grave. There lives above it the imperishable memory of an enthusiasm and a devotion which began the most glorious chapter of scientific progress in America.